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ABSTRACT

Computers have been used in a variety of applications for athletics since the late 1950's. These have ranged from computer-controlled electric scoreboards to computer-designed pole vaulting poles. Described in this paper are a computer-based athletic injury reporting system and a computer-assisted football scouting system. The injury reporting system uses an optical mark sense form on which various data concerning an athlete's injury and subsequent treatments are entered. Report programs then produce various statistics and information on player statuses for the coaching and training staffs. The football scouting system provides the scout with ready-made forms that may be used to record observations on individual plays and players. A series of reports may be requested by the user. Sample reports from the football scouting system are provided. (DGC)

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CAA: COMPUTER ASSISTED ATHLETICS

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The proliferation of computer and computing technology in the past ten years has had an effect on nearly all academic disciplines. Certainly, athletics and related programs are no exception. The utilization of computing services as well as the number of applications supporting athletics is low when compared to more traditional computer related activities (e.g., engineering, science, etc.); however, very much on the increase.

The indoctrination of students in high school and college to computers and their technology has resulted in orienting people of all disciplines to the merits of computing. This, coupled with the increasing availability of hardware, has provided the opportunity to apply the valuable resources of automation to support athletics. National exposure of professional athletics and the frequent references in the media to the pro's use of computers have also served as catalysts to many people responsible for athletic programs to investigate the computer's potential for their situation.

The use of computers by athletics and their related activities is a very recent phenomenon. However, attempts were made as early as the late 1950s to integrate computing into sports. A baseball team tried replacing the manager concept of running their team with rotating head coaches. They also used the computer to solve such problems as which relief pitcher to call in a certain situation, and probably which candidate for head coach should be next in line when the incumbent failed to yield a winner. They had several problems among which were: (a) the lack of good ball players, (b) the attitude that players should play the game without the interference of computers, and (c) the lack of credibility concerning the information furnished by the computer.

Several other experiments were tried through the early and mid 1960s. Most were indeed exploratory in nature, and required a high level of computer sophistication on the part of the user such that few, if any, were announced as successful. The introduction and ultimate availability of third generation computers, their terminal capabilities, and more usable high level languages brought a whole new base from which to apply computing to athletics and sports. Today, such things as conversational terminals, special purpose mini-computers, availability of data base technology, the potential of medium-large scale central processing units, and breadth of knowledge in the application of computing have served to provide sports and athletics with some many unique and creative systems.

Certainly one of the more common uses for the computer in support of sports and athletics is the processing of administrative data. Accounting, budgeting, and other business type functions are assisted by data processing systems both for professional and amateur programs. Such things as computerized season's ticket files and lists are often used when the number of tickets involved is very large. Most of the systems in operation that perform such functions as listed above are indirectly supportive of the athletic programs. The main theme of this paper will however, deal with applications of more direct support for athletic contests and athletes through the use of computing.

Research efforts assisted by computer modeling and testing have had a very significant impact on various sports programs. A recent television special dealing with football injuries devoted a large portion of time to the portrayal of study efforts aimed at improving the design of the football helmet. Several major universities were involved and explained their research techniques which involved a great deal of modeling and impact study analysis via computer. Should these studies result in a safer helmet, as it appears they will, the impact on the football player will be very direct and beneficial.

Another example of beneficial research that could lead to improved performance was done by Professor James B. Vernon, associate professor of mechanical engineering at the University of Southern California. Professor Vernon has designed and built a pole-vaulting pole with a bend in it.[1] He used the computer to help solve the very complex energy problems involving the motion of the vaulter, energy in the pole, etc. Optimizing on his theory and using a proper bent pole design and vaulting technique, Professor Vernon predicts the theoretical possibility of a 28½ foot vault.

Contests have been directly affected by the use of computers in many ways. Conferences have

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[1] James B. Vernon, "Pre-Bent Pole Looks Promising," The Bent of Tau Beta Pi, Fall, 1974, pp. 14-15.

scheduled their officials via computer, and used the same systems to evaluate their performance. Several specific examples of computer driven scoring and display devices have been publicized recently. A couple of years ago an IBM 1130 was mounted in a van and made the professional golf tour. The side of the van served as the scoreboard and the computer took care of keeping the scoreboard up to date as the scores for each hole came in. Certainly one of the most modern score/message boards in sports today is at the Harry S. Truman complex in Kansas City. Joe Garagiola of NBC did one of his specials on the operation of the baseball score and message board and anyone watching had to be impressed.

The professionals are not the only ones to use computers to assist in contests regulation and scoring. Lakeville Junior High, Lakeville, Minnesota used its interactive computer on the TIES (Total Information Education Systems) network for such a purpose.[2] They set pairing by weight, grade, and school for a wrestling tournament of nine teams and 150 wrestlers. Not only did the automation of the pairing process save time, it was far more equitable in its scheduling and matching of the wrestlers. Also, the 32nd Annual NCAA National Gymnastics Championship held at Pennsylvania State University used an interactive terminal system to tabulate the scores for its 43 participating institutions, 180 performers, 5,000 individual scores.[3] The intricacies of the gymnastics scoring processes were all coded into the main computer, so team and individual scores and totals were brought up to date immediately upon entry. This allowed officials, coaches, and others to gain current status reports upon demand throughout the session.

Professional football is probably one of the most prolific users of computer systems in sports today. Nearly all of the pro teams use computerized scouting reports to assist them in selecting players in the draft.[4] Player scouting is by no means the limit of pro-football's computer assistance. Opponent's tendencies on offense and defense as well as studying one's own tendencies are among the many applied users of the computer in game planning.[5] A more thorough explanation of a game scouting program and its uses will be covered later in this paper.

Many other examples could be listed from nearly all competitive sports in which the computer is used in one form or another. Specifics on many of these applications are kept very confidential by the teams using them. The advantage of a team knowing the specific breakdown of scouting data used against them would undoubtedly be a valuable asset. Having been closely involved with the development of two systems used directly to support athletics, it's very clear that such systems can be very valuable to a sports program. The description of these two systems follow:

[2] Richard Rowe, "Matching Up the Grunt and Groaners," AEDS Monitor, April, 1974 page 4.
[3] "Meet's Terminal Scores Athlet's Feats," Computerworld, December 4, 1974, page 8.
[4] Ward, Gene, "Ward to the Wise," New York Daily News, October 21, 1971, Sports Section.
[5] Kyle Rote, "Computer in the Starting Lineup," Think, October, 1973, pp. 24-28.

Athletic Injury Report System

The use of the computer to break down data on athletic injuries is natural. The process is a reasonably mundane task and very time consuming if attempted manually. However, the computer can and will perform this analysis with extreme accuracy and speed. The trainer and his staff no longer will need to spend many hours of manual processing to produce reports of their activities. These manual reports, at best, just scratched the surface of providing useful information. The use of the computer in the analysis process will allow a greater number of data items to be considered and yet require less personnel time to break down.

The procedure used at Northern Illinois University the past several years and adopted in modified form for the 1973 year by seven universities in the Mid-American Conference is based on the collection of injury data through the use of an optical mark sense (OMR) readable sheet.[6] (Figure 1) This sheet is used in the training room and data is collected for each athlete requiring the trainer's attention. Specific data items are collected about the injury and its treatments. There are two items on each side of the sheet that are somewhat unrelated to the injury itself, but absolutely required to machine process the sheets. These two items are the athlete's social security number and the injury number which is merely a sequence number denoting how many injuries the player has had requiring visits to the training room. Each of these elements is required on both sides of the sheet to insure the mechanical process of matching the information on the two sides of the collection sheet into a single machine processable record.

From looking at the sheet, it is obvious that the process of recording the data is not an insignificant task. And, indeed, a good bit of the time formerly spent on reducing injury data manually can now be used in recording the data on the OMR sheet. There are probably several justifications and rationalizations for reinvesting this time. First of all, the sheet has the capability of recording a significantly larger number of data items than are usually recorded under a manual system. The more data collected, obviously the more in depth analysis available on injuries and their treatments. The time spent coding the OMR sheets can be spread through the entire season; whereas, the manual compilation of an injury report at the end of the season would concentrate a great deal of time within a few days or weeks. Also, after using the OMR sheets for several weeks the process of recording on them becomes increasingly faster and easier.

Analysis of the injury data requires several steps. These steps are:

(1) Processing of completed forms through the OMR reading device and converting data to computer processable form.
(2) The execution of several computer programs which match the two sides of the injury form's data produced in the previous step

[6] John Hall, Alfred Kranz, Harold Morris, William Tessendorf, J. Randall Ryan, "Northern Illinois University Athletic Injury Report System," Athletic Training, December, 1974, pp. 184-185.

Side 1

Side 2

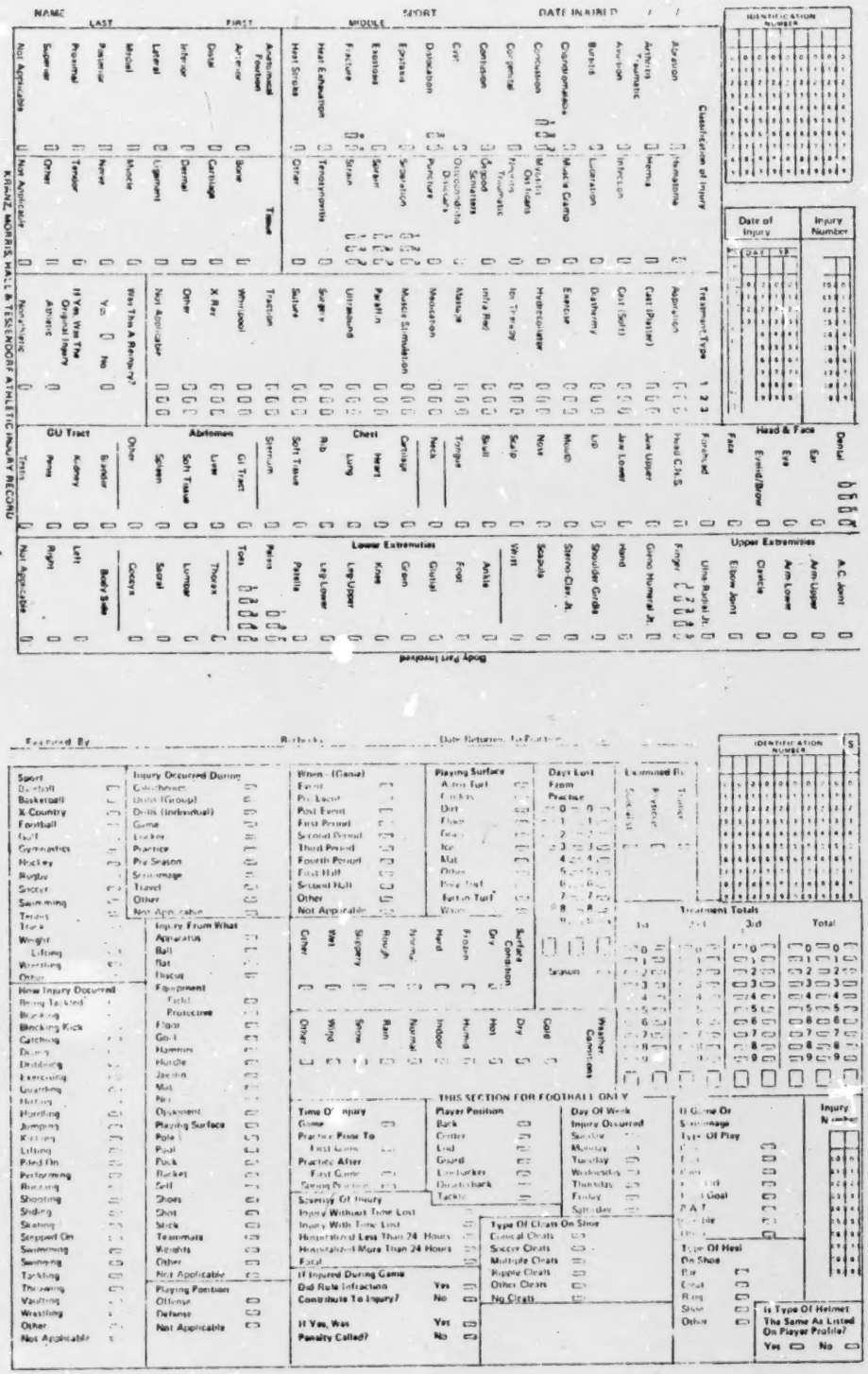

Figure 1

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1973 MAC UNIVERSITY'S SAMPLE REPORT 01/17/75 PAGE 19

FILE 1973 (CREATION DATE = 01/17/75) MAC UNIVERSITY'S INJURY FILE

CROSSTABULATION OF VAR040 PLAYER POSITION BY VAR017 CONDITION AT INJURY OCCURANCE PAGE 1 OF 1

VAR017

VAR040	COUNT / ROW PCT / COL PCT / TOT PCT	INJ APPL INCAPLE K	OTHER J	SCRIMAGE	PRE-SEAS CN G	PRACTICE F	GAME E	INDIV OR GROUP DRILLS C	INDIV OR GROUP DRILLS P	CALESTHE NICS A	ROW TOTAL
BACK	1.00	5	3	54	56	201	194	20	44	1	580
		0.9	0.5	9.3	9.7	34.7	33.4	3.4	7.6	0.2	34.8
		29.4	25.0	35.5	35.9	34.8	33.9	50.0	28.7	100.0	
		0.3	0.2	3.2	3.4	12.1	11.6	1.2	2.6	0.1	
CENTER	2.00	1	0	2	4	20	35	1	4	0	67
		1.5	0.0	3.0	6.0	29.9	52.2	1.5	6.0	0.0	4.0
		5.9	0.0	1.3	2.6	12.0	6.1	2.6	2.6	0.0	
		0.1	0.0	0.1	0.2	1.2	2.1	0.1	0.2	0.0	
END	3.00	1	2	20	30	104	93	10	57	0	320
		0.3	0.6	6.3	9.4	32.5	29.1	3.1	17.8	0.0	19.2
		5.9	16.7	13.1	19.7	18.8	16.1	25.0	36.1	0.0	
		0.1	0.1	1.2	1.8	6.2	5.6	0.6	3.4	0.0	
GUARD	4.00	3	4	16	24	80	60	3	10	0	182
		2.7	2.2	8.8	13.2	43.0	33.0	1.6	5.5	0.0	10.9
		27.4	33.3	10.5	15.8	10.4	10.5	7.5	6.0	0.0	
		0.3	0.2	1.0	1.4	4.8	3.6	0.2	0.6	0.0	
LINEBACKER	5.00	1	0	13	14	69	94	2	18	0	212
		0.5	0.0	6.1	6.6	32.5	44.3	0.9	11.8	0.0	12.7
		5.9	0.0	8.5	8.2	14.7	16.5	5.0	10.0	0.0	
		0.1	0.0	0.8	0.8	4.1	5.6	0.1	1.1	0.0	
QUARTERBACK	6.00	0	0	11	2	13	25	0	2	0	53
		0.0	0.0	20.8	3.8	24.5	47.2	0.0	3.8	0.0	3.2
		0.0	0.0	7.2	1.1	2.4	4.4	0.0	1.2	0.0	
		0.0	0.0	0.7	0.1	0.8	1.5	0.0	0.1	0.0	
TACKLE	7.00	4	0	37	26	96	91	4	21	0	253
		1.6	0.0	14.6	7.9	34.0	32.0	1.6	8.3	0.0	15.2
		23.5	0.0	24.2	13.2	15.6	14.2	10.0	12.6	0.0	
		0.2	0.0	2.2	1.6	5.8	5.4	0.2	1.3	0.0	
COLUMN TOTAL		17	12	153	156	553	572	40	167	1	1667
		1.0	0.7	9.2	9.4	33.2	34.3	2.4	10.0	0.1	100.0

NUMBER OF MISSING OBSERVATIONS = 170

Figure 2
Sample Injury Report

and the creation of a single computerized record for each injury sheet.

(3) One or more computer runs to analyze the records produced through a generalized statistical package.

Specifically, N.I.U. uses a Digitek 100 OMR mark sense reader with a magnetic tape unit to record the data in machine readable form. A utility program sort is used to order the records for each side of the sheet in social security and injury number order. A FORTRAN program is then run to combine the records for each side of the sheet and will produce an error report for sheets which do not have matching sides.

The Statistical Package for the Social Sciences (SPSS) is then used to break the data into usable information. SPSS is very convenient to use in that very little computer expertise is involved in its use. With 2-3 hours of training most anyone can learn enough about SPSS to set up the control cards for the analysis required. The ability of SPSS to combine data elements in cross-tabulating is just one of the uses for breaking down the injury data. An example report available might be a cross-tabulation of football player's position by conditions at the concurrence of the injury. (Figure 2)

It will now be possible although the programs are not yet written, to save a complete injury file for each competition year. Then an individual injury profile can be produced for each athlete at the end of his eligibility showing each injury and treatment from his first practice through his last game. This will be of immeasurable value in assisting the trainer to advise professional scouts about a player, and in planning for prevention of injuries.

In addition, it is entirely conceivable that the availability of this data can lead to some very significant research into the study and prevention of athletic injuries. Should the collection and synthesis of this data help in reducing the quantity and severity of athletic injuries any at all, it will have been worth the investment of time and energy involved in its implementation and operation.

Football Scouting System

In the fall of 1969 the football coaching staff at Northern Illinois University (NIU) used an edged punched card system for scouting their opponents. After having spent some 40-100 man-hours per week to break down scouting data, they decided there had to be a better way. The coach responsible for coordination of scouting came to the NIU computer center and asked for help. In studying the problem it was discovered that computerized scouting systems existed at other institutions. However, the decision was made to design a new system since those in existence were either unusable or unavailable.[7]

[7] J. H. Hall, "A Descriptive Analysis of a Computerized Football Scouting System" (unpublished Master's thesis, Northern Illinois University, 1972)

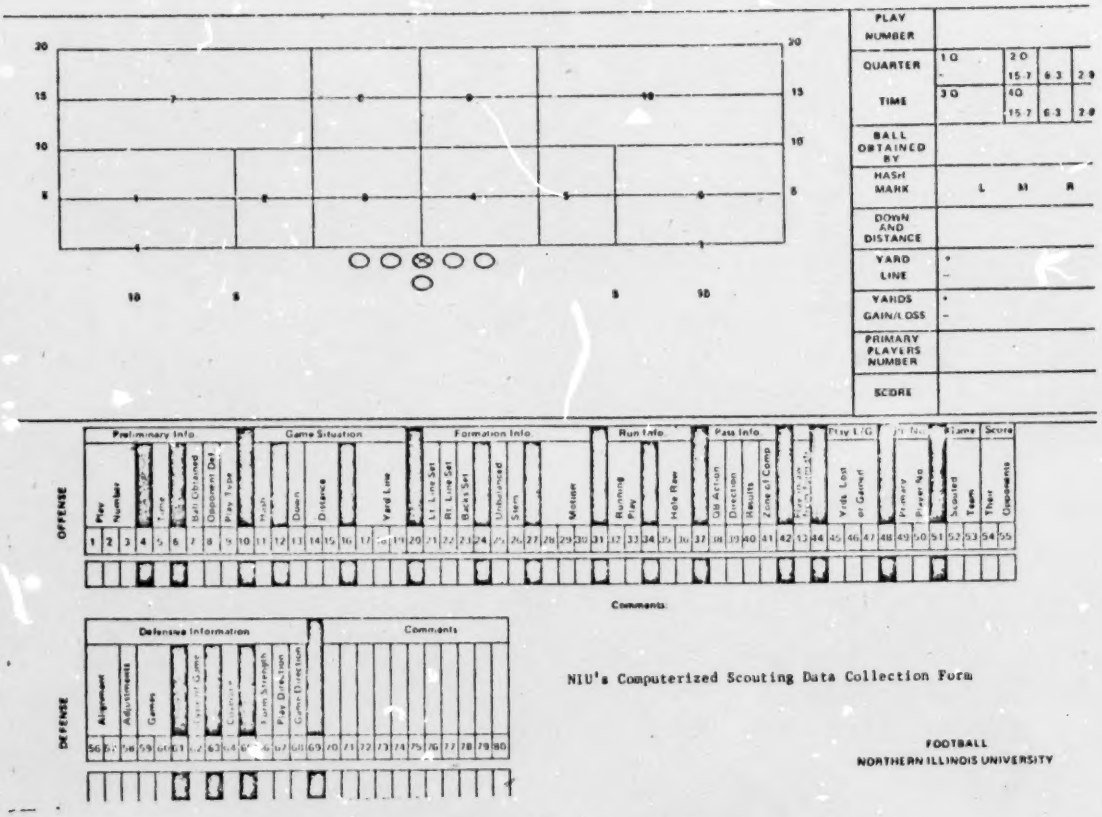

Figure 3

NORTHERN ILLINOIS UNIVERSITY
FOOTBALL SCOUTING REPORT

SAMPLE RUN WITH TEST PLAY DATA 13/23/731
SUMMARY OF RUNS FROM THE HASH MARKS

LEFT HM

RUNS TO LEFT = 1 RUNS TO RIGHT = 1

MIDDLE

RUNS TO LEFT = 1 RUNS TO RIGHT = 0

RIGHT HM

RUNS TO LEFT = 0 RUNS TO RIGHT = 1

Figure 4

The design of the scouting system was based on a thorough set of specifications for the data to be collected and reports required. The list of data elements to be used was finalized and a general purpose scouting data collection form created. (Figure 3) This form serves as both the data collection device for the scout and as an input document to a keypunch operator.

Programming of the system was done in the IBM FORTRAN IV G. The program contains three distinct sections. These sections are: for storage allocation and definition; the reading, editing, and storing of data; and report generation.

Storage allocation and definition initializes the descriptor information and allocates data storage and work space in the program. The next section reads the data cards, edits the data, and stores the valid data in the space allocated by the previous part of the program. The reports are then generated and printed. The reports generated are as follows:

1. Chronological List of Offensive Plays
2. Summary of Running Plays by Play Type
3. Summary of Running Plays Into and Away from Strength.
4. Summary of Pass Plays Into and Away from Strength
5. Summary of Plays by Backfield Alignment
6. Summary of Tendencies from the Hash Marks (Figure 4)
7. Summary of Plays by Line and Backfield Formation Combination
8. Summary of Plays by Down and Distance
9. Summary of Running Plays Through Each Hole
10. Summary of Pass Plays to Each Receiving Zone.
11. Summary of Each Principal Player's Play
12. Summary of Offensive Plays by Field Position
13. Summary of Backfield in Motion Plays
14. Chronological List of Defensive Plays
15. Summary of Defensive Success Against Running Plays Through Each Hole
16. Summary of Defensive Success Against Pass Plays to Each Receiving Zone
17. Summary of Defensive Alignments by Field Position

The computerized football scouting system requires human judgment and interpretation in analyzing the reports produced. The operation of the system provides for scouting data to be reduced into a much finer breakdown than the manual method within the time constraints involved. The coaching staff found their time investment in breaking down computerized scouting reports to be between 10% and 40% of what it was with the previously used edged punched cards. The computer runs take about 10 cpu seconds per game on an IBM 360/67. The NIU system would probably require minor modifications to match the naming conventions of another coaching staff, but would be usable to another team with similar report requirements.

In summary, it is certainly clear that computers are now an integral part of athletics. There are certainly more applications than have been referenced in this paper. Just as certainly, the creativity of computer people, coaches, administrators, and athletes will lead to many more useful applications for the computer in the future to help play the game.

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